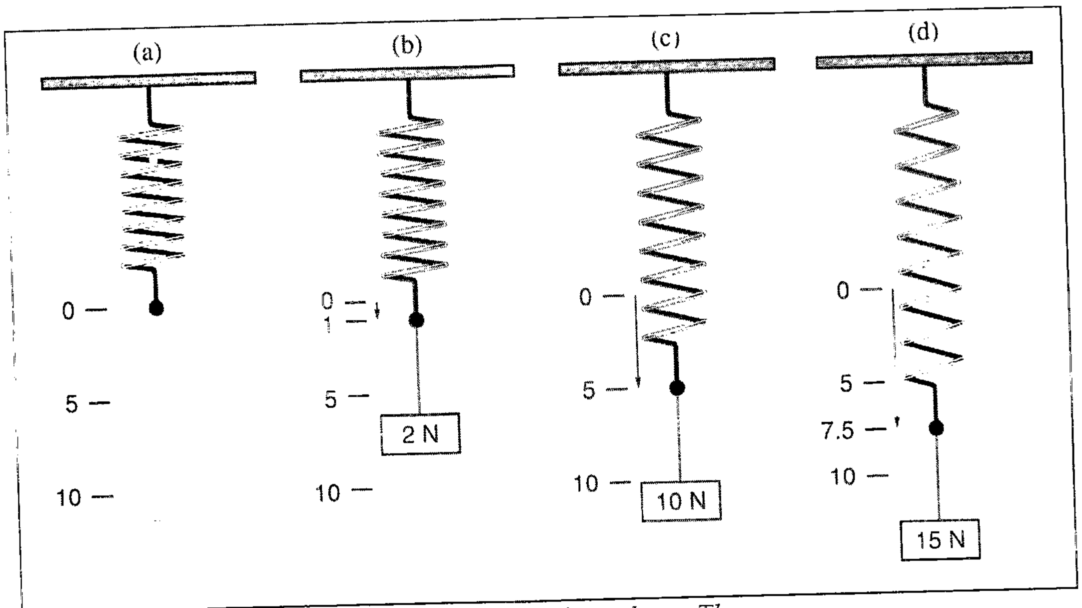
Hooke's Law

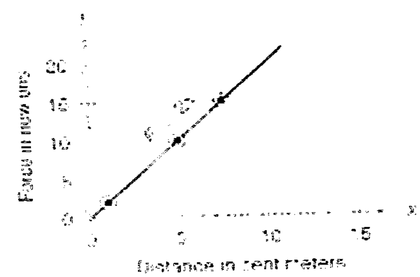
Robert Hooke was an English chemist and Physicist who was a contemporary of Newton. Hooke did research on springs, and he found that the distance a spring would stretch, or compress was directly proportional to the force applied. We call this relationship Hooke's Law.

$$F = -k\,x$$

In the diagram below I show a spring at rest. Then (b) we find that the 2 Newton weight stretches the spring 1 centimeter. In (c) we find that a 10 Newton weight stretches the spring 5 centimeters. In (d) we find that a 15 Newton weight stretches the spring 7.5 centimeters.

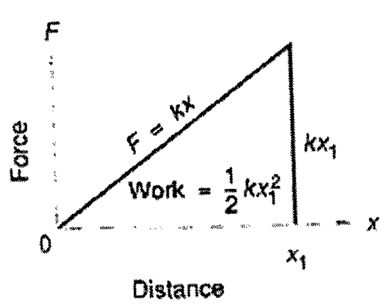


The graph below is the graph of force versus the distance for these data. The circles around the dots in the graph indicate that these are experimental data points. We see that the graph is a straight line and that the equation of the line is $F = 2\,x$. This reinforces Hooke's Law which is stated as



$$F = -k\,x$$

Potential energy and kinetic energy are forms of mechanical energy and represent an ability to do mechanical work. If we compress a spring, we move a force through a distance and do work on the spring. This energy is stored in the spring, and when the spring returns to its original length, it returns the energy we have stored in it. This storage of energy in a spring is also possible when the work on the spring stretches the spring. We say that energy stored in a spring because of the elasticity of the spring is ***elastic potential energy.***



The graph shown displays a force applied to a spring as a function of the distance the spring is compressed or elongated from its at rest position. Because the forces applied do not cause the spring to exceed its elastic limit, the graph is a straight line. Since force times distance equals mechanical work, the area between the graph and the x axis for an interval of distance represents the work performed during that interval. The equation of the line is $F = -k\,x$, where k is the spring constant and has the units of force over distance. (next page)

The Area under the graph represents the work done by the spring or work = ½ B H with the unit being joules.

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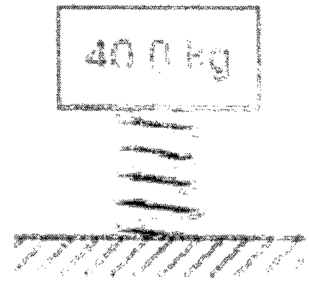
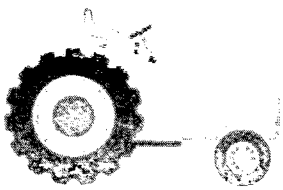
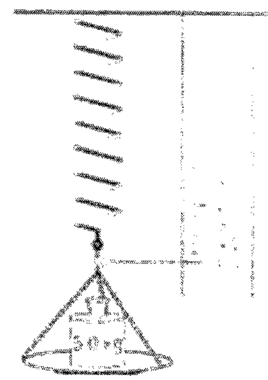
Problems: *1) A 40.0-kilogram mass was set on a spring whose spring constant was 800 newtons per meter. How far was the spring compressed? How much work was done on the spring?*

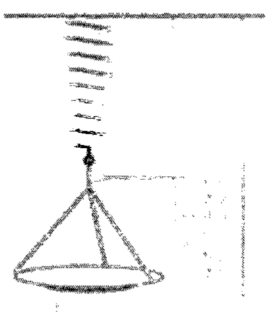


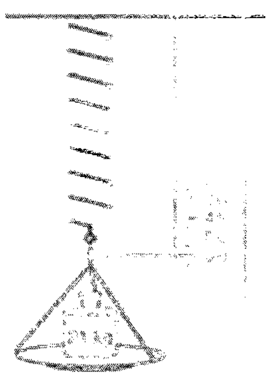


2) A tractor seat is supported by a single spring which compresses 2.00 centimeters when Ralph sits on it. (a) If the seat supports 90.0 percent of Ralph's 320-newton weight, find the spring constant, (b) How much work is done in compressing this spring?



3) A spring scale stretches 5.0 cm when a 5.0-kg mass is placed on the tray. (a) What is the spring constant? (b) How much work is done in stretching the spring from 0 to 5.0 cm?





4) A spring scale stretched from 2.0 centimeters to 6.0 centimeters when Barry put a 21-kilogram mass on the tray. (a) What was the spring constant? (b) How much work was done in stretching the spring from 2.0 cm to 6.0 cm?

5) A block is attached to a spring and allowed to stretch the spring 3.5 centimeters, as shown, (a) If the block has a mass of 15 kilograms, what is the spring constant? (b) How much work is done in stretching the spring?